



METROPOLITAN
TRANSPORTATION
COMMISSION

IntelliDriveSM Technologies to Support HOT Lane Operations

Workshop Summary

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1. Introduction

This summary of a workshop held on October 21, 2009 is prepared for the Metropolitan Transportation Commission (MTC). MTC is the transportation planning, coordinating and financing agency for the nine-county San Francisco Bay Area. MTC manages a range of technology projects intended to improve transportation system management in the region, including having an active role in the national IntelliDriveSM program.

In addition, the Commissioners of MTC serve as the Bay Area Toll Authority (BATA), a separate public agency formed by the California Legislature in 1997, with responsibilities that include administration of all Bay Area toll revenue and joint oversight of the toll bridge construction program with Caltrans and the California Transportation Commission. In April 2009, MTC adopted the long-range *Transportation 2035 Plan*, which commits to developing an 800-mile express lane network throughout the region.

A grant received through the Urban Partnership Program (UPP), sponsored by the U.S. Department of Transportation (U.S. DOT), offers MTC the opportunity to implement a pilot program to demonstrate the advanced technology capabilities of IntelliDrive to improve travel demand strategies. MTC plans to analyze and test the feasibility and potential value of using IntelliDrive technologies to support high occupancy toll (HOT) and express lane operations.

The overall project is divided into two phases. Phase 1 covers the preparation of a white paper and a national workshop which is the subject of this summary. Phase 2 will comprise a field demonstration of IntelliDrive technologies to support operations on a selected express lane facility in the Bay Area.

The purpose of the white paper was to identify specific concepts that are feasible for, and would benefit from, field testing of HOT lane operations using IntelliDrive technologies. The white paper identified opportunities and challenges associated with IntelliDrive technologies and applications that could support HOT lane operations. The paper provided recommendations on specific components of an IntelliDrive HOT lane project that can be demonstrated during Phase 2. The workshop summarized here provided an opportunity to present the findings of the white paper and a means for private industry and public agencies to provide feedback and engage in discussions about the white paper's recommendations and the subsequent field demonstration in Phase 2.

2. Workshop Discussions

2.1 Introduction

The workshop was held at the Joseph P. Bort MetroCenter in Oakland, California on October 21, 2009. The workshop was also available via webinar. Fifty-nine people attended the workshop in person, including MTC staff members, members of the contractor team, and representatives from various federal, state and local transportation agencies, university-based transportation centers, vendors, and

transportation consultants. In addition to those present, 47 participants attended remotely via webinar. A list of attendees is provided in Appendix A.

The workshop was broadly divided into two sessions. The morning sessions comprised a series of presentations accompanied by opportunities for the participants to ask questions. In the afternoon, the in-person attendees were divided into three breakout groups for more detailed discussion on the recommended use cases presented in the white paper. Webinar Participants were able to submit comments and questions via email. A copy of the workshop agenda is provided in Appendix B, and copies of the presentation slides are included in Appendix C.

2.2 Presentations

At the start of the presentations, MTC staff member and workshop moderator, Carol Kuester, welcomed all participants, introduced the IntelliDrive HOT Lane project team and reviewed the agenda. All present were invited to introduce themselves.

Following her introductory remarks, Ms. Kuester presented the purpose and objectives of the workshop, providing its context within MTC's wider Urban Partnership Program effort to analyze and test the feasibility and potential value of using IntelliDrive technologies to support high occupancy toll (HOT) and express lane operations in the San Francisco Bay Area. Likewise, she offered an overview of the MTC, its structure, activities, and relationships with other transportation focused agencies. Additionally, she presented specifics about the current configuration and proposed development of the San Francisco Bay Area's Regional Express Lane Network.

The workshop presentation provided an opportunity to clarify the White Paper's discussion of proposed ingress and egress approaches for the Bay Area Express Lane Network. For completeness, this clarification is included as Appendix D in this workshop summary.

I. Following is a summary of the questions posed and answers provided following the Workshop Purpose and Objectives section of the presentation and the Overview of Regional Express Lane Network section of the presentation.

1. Overall MTC Vision and Plan for Express Lanes in the Region

A question was posed regarding MTC's vision for IntelliDrive in express lanes beyond Phase 2 of this specific IntelliDrive project.

- MTC staff responded by explaining that MTC's vision is still evolving. As an agency, MTC has been involved in Vehicle Infrastructure Integration (VII)/IntelliDrive efforts because they view them as a key component of the next generation of traffic data collection, traffic system management, and traveler information. MTC is hopeful that the current IntelliDrive HOT Lane project will be relevant to meeting current needs in

implementing the Regional Express Lane Network. Specifically, MTC is very interested in seeing whether there is IntelliDrive technology that can help support that objective. The direction that will eventually emerge is largely dependent upon the outcomes of Phase 2 of the current project. MTC believes that the results of the Phase 2 demonstrations will inform that direction, and make a contribution to both regional and national understanding of the potential of IntelliDrive technologies.

Lisa Klein, from MTC's HOT lane project group, joined the discussion.

2. Challenges Other Regions Have Encountered in Implementing HOT Lanes

The example of Seattle HOT lanes was offered as an instance in which agency revenues turned out to be far less than estimated, actually resulting in an operating loss. Because MTC is anticipating that revenue generated from HOT lanes will be available to assist the region in paying for other congestion reduction measures, including regional transit, the question was raised, "How conservative are the revenue estimates and what will happen if the revenues don't come in as expected? How will that impact next steps?"

- MTC staff responded that while there were a number of reasons why Seattle cost and revenue estimates were as they were, that example may offer some direct lessons, though the regional outlook differs. MTC planning level estimates are continually being refined. However, if revenues are lower than projected, then most likely the roll out of the Regional Express Lane Network would be slowed.

3. HOT Lane Pricing Issues

A number of questions and discussion points were raised related to HOT lane pricing issues.

3.1 A question was raised as to whether MTC is considering extending pricing to all freeway lanes.

- MTC staff explained that ideally MTC would like to have the ability to charge all vehicles in all lanes at all times. Such a situation would open up a lot of pricing options. However, that situation does not reflect current Regional Express Lane Network policy, nor is there a clear idea of how it might be implemented. The current proposal is to always allow appropriate carpools and all buses to use the express lanes for free.

3.2 A participant questioned the accuracy of a presentation slide about a proven corridor management tool that referenced Orange County's 100% improvement in throughput by adding one HOT lane. The participant asserted that to get that kind of improvement you would have to add at least 3 lanes.

- MTC staff responded that the statistic was pulled from another presentation; that they could not respond to the accuracy of the slide without additional research.

4. Consumer Testing/Public Perceptions of HOT Lanes and Equity Issues

The question was raised about whether MTC had done any consumer testing related either to (High Occupancy Vehicle) HOV occupancy changes or for express lane toll charging, and if yes, what were the results?

- MTC staff reported that this was an important issue because there is perceived inequity in HOT lanes, and public outreach will be critical as the HOT lane projects roll out. At this point MTC has completed a fair amount of research, specifically extensive focus groups and polling in the I-680 corridor and in the Santa Clara area. MTC has learned:
 - The idea of changing HOV occupancy from 2 to 3 is extremely unpopular. However, because the occupancy levels for many of the existing carpool lanes are not rising during peak periods, this is going to be a decision that the MTC will have to consider regardless of whether HOT lanes are implemented. It's a difficult decision with a potentially unpopular outcome.
 - The typical equity concerns raised are not what one might read in the newspaper and what is often presented. In the focus group setting, MTC found that people of all income levels support the concept of HOT lanes and see the value in paying for them when they need them. Trades people tend to strongly support them. The whole equity debate is more nuanced than it's often presented. There seems to be consistent support for the concept, particularly when benefits are discussed (i.e., it has been successful elsewhere, you can invest money in transit improvements, and there are reductions in emissions).
- When MTC did polling for its last long range plan a year and a half ago, they got a 50-60% approval rating for the concept of a network of HOT lanes. The approval rating has proven to be about the same in the polling work done for the I-680 corridor; with 60%, or perhaps as high as 70% approval.

II. Following is a summary of the questions posed and answers provided following the presentation of the white paper *"IntelliDrive Technologies to Support Hot Lane Operations."*

Details of the white paper were presented by Carol Kuester and Janet Banner of MTC. The bulk of the participant discussion was centered on enforcement; vehicle identification and occupancy detection; toll collection and back-office toll processing; and technology, device, and interface issues. Additionally, a number of workshop participants offered comments and posed questions specific to the use cases set forth in the white paper.

1. Enforcement, Vehicle Identification and Occupancy Detection

1.1 There was discussion about image-based technologies that are on the market today and are currently being used by law enforcement agencies that give identification information and can be used in a network-based environment. One participant cited the use of this technology in Colorado for enforcement, including toll evasion. MTC was asked if some thought had been put into taking advantage of these proven license plate recognition (LPR) systems.

- MTC staff explained that while not planned for initial deployment upon the I-680 HOT lane opening, they have had discussions regionally about using a video enforcement system that would supplement California Highway Patrol (CHP) enforcement. This would be an expansion of the same system that is currently used on toll gantries on the bridges into the HOT/express lane network.

1.2. A California PATH, UC Berkeley representative described work on a project in San Diego. This involves testing technologies that could help enforcement. One of the technologies being tested is the infrared camera for vehicle occupancy detection. He pointed out that the real strengths of an IntelliDrive program lie in the two-way communication between vehicle and roadway. He suggested that whatever test cases are proposed and implemented should take advantage of this capability, as it is key to addressing enforcement.

1.3. The topic of vehicle occupancy detection was raised and it was pointed out that the information is already available on board the vehicle via seat sensors and seat belt employment but that the use cases do not address this potential. Rather, the discussion centers on switchable transponders or taking the tag off rather than on the possibility of grabbing onboard diagnostic data. The participant suggested that it would not be too great a leap to link this to IntelliDrive through existing channels.

- The project team explained that there will be opportunity to discuss this issue in more detail after the recommended use cases are presented. Certainly this was something that was of great interest to the stakeholders that were interviewed. The reason it did not move forward into the recommendations was due to the challenges posed by implementation. There were some conversations with representatives of the automotive industry that indicated that this was going to be challenging for them. They reached out to some Original Equipment Manufacturers (OEMs) in the course of this work on the white paper. It was found that OEMs have concerns about allowing access to the data, as it is a component of a critical safety system. While a challenge, MTC intends to pursue this, hoping to engage at least one auto manufacturer, possibly through a limited test.
- This discussion was supplemented by the following participant input: There is an SAE DSRC Technical Committee working on DSRC standards, and data elements relating to vehicle occupancy are not

included the message set. This is where other stakeholders would be welcome to participate, within the framework of SAE. It was suggested that as a strategic imperative, whoever is involved in implementing Phase 2 should engage strongly with this group.

1.4. The white paper lists several potential vendors for Dual Mode 915 MHz RFID and 5.9 GHz DSRC Tolling Systems. A participant questioned why only those specific firms were listed and others were omitted.

- MTC responded that while every vendor was not included, there was no intent to omit anyone who had a solution. MTC would like to hear from firms with solutions to technological areas applicable to the Phase 2 IntelliDrive demonstrations. Information received from vendors since the publication of the white paper is included in Appendix D of this summary.

2. Toll Collection and Back-Office Toll Processing

A number of issues arose from this discussion; paramount was the need to explore the specific advantages IntelliDrive offers in supporting the goal of reducing back-office operations. MTC noted that the purpose of the Back-Office Toll Collection Use Case is to demonstrate the role front end technologies can play in capturing toll information and processing debit/credit cards. There are already similar examples in New York City and Utah.

2.1. Another participant raised the issue of shifting paradigms. He is finding that typical traditional tolling paradigms, once IntelliDrive and related technologies are engaged, no longer apply. A larger and more varied approach must be employed in dealing with customers.

- It was noted by another participant that a big consideration is that agencies will have to give up pre-paid tolls and move to the point of sale (POS) model. This move has implications for cash flow and risk, among others.

2.2. MTC was asked to elaborate on why current tolling technology is problematic for continuous access to HOT lanes and how equipment on an overhead gantry can be instructive on the question of continuous access.

- Mixon Hill clarified that the continuous access topic has not been analyzed in the white paper in any real depth. While it was referenced in the toll collection use case, this was an attempt to consider equipment configurations that would allow further exploration. The intent would be to set up a specific test that could assess the ability of DSRC equipment to collect tolls at any point at which a vehicle entered the express lane, rather than simply at a designated toll collection zone. (Additional discussion of continuous access to express lanes based on subsequent discussions with CHP is provided in Appendix E.)

2.3. It was suggested that credit/debit card information be tied to the issuance of the tag and could be updated outside the vehicle so as to avoid potential driver distraction issues or the need for complex human machine interfaces (HMI) within the vehicle.

2.4. One participant explored the move toward having 3rd party service providers aggregating toll collection and simplifying the actual financial exchanges and operations. He posed a question as to the specific advantages that IntelliDrive can offer over data exchange and software management on the back end.

- Mixon Hill offered that the focus of this use case is on front end technologies and their role.
- Another participant suggested that the use case should not focus on the back end. Moving into debit card processing will not do anything to the back end. That is handled by the processors and there are established rules that we have to abide by. The focus should be the front end and the capture of that transaction, which was discussed in the paper. The use case should be an end-to-end transaction processing of credit/debit cards for the payment of the toll/fee to use the lane. The challenge is in the open payment system of the PCI (Payment Card Industry). We're proposing putting in place a device which captures credit/debit card numbers, and so it will need to be compliant with PCI standards. There's also an issue that is currently being debated in the financial services community, which is end-to-end encryption of these transactions.

3. Technology, Device, and Interface Issues

3.1. It was pointed out that there is a group of stakeholders that use DSRC as primarily a communication link for safety systems. Active safety systems are the primary concern of DSRC and safety events will dominate the channel. It would be important to assess channel load with simultaneous safety events and toll collection, as well as other potential new applications, in order to demonstrate to stakeholders that tolling can be done without compromising the safety events.

3.2. A webinar participant asked the question, "Is the use of dead reckoning to augment GPS or DGPS being considered to assess lane-level accuracy?"

- MTC staff responded that this might be something to be considered. Another participant added that this is being used in Germany as part of their GPS-based truck tolling system.

3.3. An inquiry was made about the GPS pricing demo in Seattle and if it provided any information on evaluating continuous access.

- That test had a completely different focus, not just looking at freeways but also arterials. The test was focused on changing travel behavior by giving drivers information about pricing, route, time savings, etc.

3.4. There were questions posed regarding testing with heavier vehicles, such as trucks or buses, as well as motorcycles and hybrid vehicles.

- MTC addressed the heavier vehicles by stating that buses would be allowed with no charge and trucks would not be allowed in HOT lanes, so no detection is necessary for either.

- As for motorcycles and hybrids, the plan is that vehicles that are currently allowed to use HOV lanes without a fee would also be able to use HOT/express lanes for free, regardless of occupancy. Future actions depend upon the California law that currently allows for a fixed number of permits to be issued for hybrid and alternative fuel vehicles to use HOV lanes without cost/penalty regardless of occupancy. Under the current authorization, no more permits are available. Legal considerations will guide decisions.

3.5. A participant suggested that the use case ought to address an ultimate deployment scenario. This should examine the limitations of DSRC and other communications technologies when it will be used in tens of thousands of vehicles. A webinar participant followed up by asking for information on the OmniAir Consortium.

- MTC responded that OmniAir is the 5.9 GHz certification body that is working toward interoperability.

3.6. A comment and cautionary note regarding HMI was made: a California PATH, UC Berkeley representative noted that HMI was presented as a single bullet in the MTC presentation and one paragraph in the white paper. In any experiment with naïve users/drivers, it was suggested that a much more thorough examination of HMI is warranted. It was also noted that nothing will be learned from CICAS-V regarding HMI, because that was not the intent of the project.

- MTC responded that the white paper does differentiate testing that we can do with general public commuters that are using the corridor, and testing that is going to require professional drivers. Any testing that uses a prototype HMI would use professional drivers in a controlled test situation. This will be addressed in Phase 2.

4. Recommended Use Cases and Demonstration Corridor

4.1. It was noted that the three recommended use cases do not directly match the equivalent use cases described earlier in the white paper, and, in fact, include components of several of the nine initial use cases. It was recommended that a mapping of the initial use cases to the recommended use cases be provided.

- A mapping of the use cases is provided in Appendix F.

4.2. One participant expressed surprise at MTC's selection of use cases. The point was made that there is a great deal already known about the three selected, and that they are working well. Therefore, why isn't MTC looking at other use cases that focus on something that the industry doesn't already know so much about? For example, buffer zone violations would be a great use case.

- MTC responded that monitoring buffer zone violations could be a challenge, requiring accurate lane-level positioning capability. An assessment of this capability has been included in the toll collection use case. MTC will continue to define the recommended use cases. There are still a lot of questions that need to be answered and details to be fleshed

out which may provide an opportunity for other components of interest to be included in the Phase 2 demonstration.

4.3. Regarding the I-680 express lanes that have three entrance points and three exit points, it was asked if they have been designed using different kinds of transitions to see how they work.

- MTC responded that all entrances and exits use the same transition lane design.

5. Proposed Project Schedule

There was strong interest in Phase 2 activities among participants. Multiple participants requested that MTC elaborate on the project schedule and provide specifics on when MTC would put additional work out for bid.

- MTC staff explained that the project milestones were developed in discussion and in alignment with the UPP delivery schedule. MTC expects to go out to bid for a Phase 2 consultant in spring 2010 with the caveat that the availability of the express lane corridor will impact that procurement schedule.

2.3 Breakout Groups

In the afternoon, workshop participants had the opportunity to select one of three facilitated discussion groups focusing on a different recommended use case: toll collection; back-office toll processing; or traveler information. Each group had a facilitator and a note taker, and each was tasked with exploring three areas relative to the use case: 1) the use case itself -- relevance, suggestions, improvements; 2) technical and operational issues; and 3) other recommendations or opportunities relating to the overall project. Below is a summary of each facilitated group discussion.

2.3.1 Recommended Use Case #1: Toll Collection

Definition of Stakeholders

1. Initial discussion centered on defining the stakeholders for the field tests. Potential stakeholders could be as follows:
 - a. Travelers – customers that would use the HOT lane corridor. One perspective focused on what will motivate consumers to purchase a vehicle equipped with IntelliDrive technologies for tolling. Will there be incentives in terms of HOT lane use, price discounts, or greater functionality that would incentivize a user to buy an equipped vehicle?
 - b. Operating agencies – The Bay Area Toll Authority (BATA), which is looking for a system to help reduce costs and improve operations.
 - c. On-board Equipment Manufacturers (OEMs) – the companies that would ultimately supply onboard equipment in vehicles.

2. It was discussed that all of these stakeholder groups could benefit from the field tests in a test corridor.
3. The importance between technology, operations, and policy was also discussed. The technology may allow for new operating strategies or policy to be set which can improve the overall operation of the HOT lane or corridor. Operationally, technology may allow for new pricing strategies that would better manage traffic flow in the corridor. In terms of policy, how does the technology impact the need for toll tags or in-vehicle equipment? Can a traveler in Sacramento travel on the Bay Area HOT lanes without having to purchase a tag?

Purpose of Toll Collection Field Test

1. There was discussion on what the purpose of the field test for the toll collection use case was. One potential was to show how IntelliDrive technologies could improve on how toll collection is done today. Some of the challenges today include the infrastructure needed to mount toll collection technology and the limited “zone” where the toll collection is conducted.
2. Another potential purpose proposed that the field test should show that IntelliDrive technologies could replicate today’s toll collection technology; thus, opening the door to other IntelliDrive applications beyond just toll collection. For example, successful testing of IntelliDrive technologies for toll collection might generate greater momentum toward national toll collection interoperability.

Toll Collection Use Case Testing

1. Several applications were discussed for their potential for being tested under the toll collection use case. Those ideas are as follows:
 - a. Can IntelliDrive toll collection technologies reduce the need for toll equipment infrastructure? The poles and gantries for mounting equipment have a significant cost. If the technology could reduce these costs, there would be a benefit to the agencies responsible for the construction and operation of toll collection systems.
 - b. Can IntelliDrive toll collection technologies improve enforcement?
 - i. Can more violators be identified?
 - ii. Is there less revenue loss?
 - iii. Is it more difficult for “cheaters” to beat the system?
 - c. Can IntelliDrive toll collection technologies be used to enforce buffer zone violations (i.e., weaving in and out of the HOT lane to avoid congestion, gain access, or to avoid toll collection)? This would reduce or remove the need for the California Highway Patrol in the enforcement process.
 - d. Can IntelliDrive toll collection technologies collect tolls by vehicle occupancy?

- e. Can IntelliDrive toll collection technologies be used to collect traffic management data in a corridor? The operational goal is to keep the HOT lanes working at free flow conditions. For example, can the technology continuously monitor the state of traffic in the HOT lanes?
- f. Can IntelliDrive toll collection technologies assist in HOT lane access operation? For example, allowing drivers to enter and exit the lane with more freedom could assist with traffic operations issues at access points. Technology must collect the appropriate toll with varying points of access.
- g. Can IntelliDrive toll collection technologies assist with dynamic pricing strategies? The ability of the technology will have an impact on the types of pricing strategies that can be entertained by the operating agencies. In addition, the ability of the toll collection technology may allow for more fidelity in charging tolls along a HOT lane corridor. Some other pricing scenarios were identified as follows:
 - i. Toll price could be paid at a gantry (e.g., open tolling system).
 - ii. Toll price could be paid by the mile.
 - iii. Toll price could be paid by the minutes saved.
 - iv. Cordon pricing.
- h. How does toll collection work for the consumer (i.e., traveler in the corridor)? How complicated is it for the driver to pay the toll? What is required in terms of interaction with the toll tag technology?

Toll Collection Technology Testing

1. The testing of the technology for toll collection needs to address the following items:
 - a. The range over which the technology performs.
 - b. The lane-level accuracy of the technology. It was generally felt that less than a meter was necessary accuracy for determining which lane a vehicle was in (or not in).
2. The technology tests should be baselined against the current toll collection equipment performance as well as some ground truth data.
3. The technology testing can contribute to the generation and refinement of standards (e.g., DSRC).
4. The in-vehicle technology must meet vehicle codes to be fully operational.

Discussion of I-680 as a Test Corridor

1. There was discussion as to the viability of the I-680 corridor as a test corridor. There were some positive attributes of the I-680 corridor identified:
 - a. There is challenging horizontal geometry that will broaden the testing of any technologies.
 - b. There is challenging vertical geometry that will broaden the testing of any technologies.

2. The group also discussed the importance of testing with consideration of the northbound I-680 lanes. Some equipped vehicles should be run in the northbound general purpose lanes to ensure that there are no toll collection issues with vehicles in the southbound HOT lane.

Toll Collection Vendor Interest

1. The vendors in the breakout session confirmed the importance of the toll collection use case.
2. There was a strong suggestion that the use case should not test what current technology does today, but should test the new, transformational applications that could come from IntelliDrive technologies.

Discussion of Phase 2 Procurement

1. There was some discussion of MTC's Phase 2 procurement. Group members discussed the relationship between the approach in the RFP with the way firms (or teams of firms) would respond to the RFP. For example, MTC could use a one-step procurement where the selected firm or team would be responsible for the design/build of the corridor test. MTC could alternatively use a two-step procurement where the test could be designed independent of vendor or technology in the first step and the technology could be procured in the second step.
2. There was also discussion as to whether MTC would be prescriptive in their testing requirements or allow the vendors to assist in defining the test. The thought was that the testing requirements may not be suitable for one technology, but modification of the testing requirements, without altering the intent of the testing, would allow some technology to be more successful in meeting testing requirements.
3. There was discussion that the use case testing should include an OEM.
4. It was also discussed that either transit fleets in the corridor or rental car fleets in the region could be used.
5. The Phase 2 field test should address the transition plan from the current toll collection state to the future toll collection state with IntelliDrive technologies.
6. There was also discussion as to whether the field tests could help match the technology with the possible lane configurations and infrastructure design. For example, will the tests result in the determination that IntelliDrive technologies are appropriate for specific HOT lane design configurations?

2.3.2 Recommended Use Case #2: Back-Office Toll Processing

Use Case #2 - General

There was general agreement that the Back-Office Toll Processing Use Case was viable for Phase 2. However, a number of suggestions were made.

It was suggested that the use case should be broader in scope and should address “end-to-end payment” rather than just toll collection. The IntelliDrive Payments ConOps under development by OmniAir/BAH addresses tolling, retail payments, entertainment services, and parking; and considers in-vehicle, roadside and back-office aspects.

Use Case #2 - Suggestions and Recommendations

It was noted that there are a number of institutional/administrative issues that should also be addressed in the use case. For example, BATA must provide back-office reciprocity to other toll agencies in California. This will also be a different business model for BATA, which is used to having prepaid tolls that are good for cash flow. It was asked how BATA would know exactly when/where the toll transactions took place if BATA was receiving batched payments directly from a credit card company in the future. It was pointed out that the processor (credit card company) would provide a detailed transaction report to BATA. It was also mentioned that the number of individual transactions will skyrocket, but Apple iTunes has perfected the process of aggregating multiple small transactions.

It is also unlikely that 100% of users will use a credit card for payment, so alternatives will still need to be provided. It was suggested that stored value cards, similar to those used in comparable applications in Japan and Singapore, could be appropriate. It was suggested that whatever type of card is used, this could allow the user to accumulate “credits” for future transit use.

It was pointed out that security is a big issue. There will be a need to securely store credit or debit card information on the IntelliDrive device. There are major efforts underway to determine end-to-end security solutions. Security is compromised all the time. The cellular phone industry has made good progress in this area.

For any new solution, BATA will still need toll evasion enforcement. This may require BATA to maintain some independent infrastructure and back-office capabilities. BATA will also need some level of customer service for dispute resolution (for example, when a customer says they were charged the wrong toll). Typically, credit card users can call either the merchant and/or the credit card company when they have a dispute. It was suggested that an IntelliDrive in-vehicle device could store an electronic receipt once the vehicle enters the toll zone and payment is negotiated.

There was discussion about whether the necessary industries would be willing to participate in a test of the back-office use case. It was suggested that electronic payment is the “next frontier” and so there would be strong interest. There are companies that deal with credit card transaction aggregation; third party transaction processors; and stand-alone contactless payment device providers; all of which would likely be willing to participate.

The use case may need to use a dummy stream of data, rather than actual credit card transactions.

Finally, it was suggested that the work done by NY MTA and the BART/Sprint phone payment projects could be models for this use case.

Other Technical and Operational Issues

Buffer zone violations are a real problem and use of an IntelliDrive solution would be very helpful. GPS with a lane-level capability would be important. GPS data could be captured on an in-vehicle device when the vehicle enters a lane and used to resolve disputes about vehicle locations. This would require integration of the devices.

GPS could also be important for enabling continuous access.

Other Use Cases

It was recommended that an enforcement use case should be carried forward to Phase 2.

It was suggested that more attention should be given to dynamic pricing (although this is already in the traveler information use case). In particular, it is important to link dynamic pricing to revenue collection: how do we make sure that we are collecting the correct amount of revenue, and how do we audit/reconcile these amounts?

2.3.3 Recommended Use Case #3: Traveler Information

Use Case #3 - Suggestions and Recommendations

There was active discussion on Use Case #3 from a variety of perspectives of the group participants. The overall theme of the conversation could be characterized by the question, “What is the purpose of this field test?” Is the primary purpose to strictly test the ability to transfer information through various technologies, or is it to evaluate alternative technology approaches that address the information drivers really want in a HOT lane/express lane environment?

The second question represents the concept of “user-centered design” where any technology design and evaluation begins with the assessment of a number of questions: who the end user is, what driving tasks they are performing, what decisions they need to make, and what their information needs are (price, comparative travel times, short-reach speeds, destination travel time, incidents, weather, etc.). The answers could be gained from focus groups, for example. Driver simulation was also mentioned as a method to test the value and usability of in-vehicle traveler information.

While the group generally agreed that user-centered design was important, there was recognition that the entire Phase 2 budget could be consumed by this one activity. Given that, the group reviewed the specific testing elements for Use Case #3:

- Price – Among the group participants, there was debate as to the value of providing this information in the vehicle. For the purposes of the test

corridor, the price will conceivably be “locked in” at the entry point. Therefore, there is no need to provide price information within the express lane, only to users in the general purpose lanes upstream that may be contemplating access to the express lanes. On the other hand, there are broader issues beyond this particular test corridor that come into play, namely multiple destinations and linked facilities (whereas prices for all trip options cannot be adequately displayed on roadside signing).

- In-vehicle account management – Of the three elements, this was considered the lowest priority and its value was questioned. The business rules of the operating agency will dictate whether or not this is viable. How will the payment process work? Will pre-paid accounts continue to be the preferred method? If so, a mechanism is already built in to the account management system to replenish the user’s account. Is there a preference to migrating to another method (as illustrated in use case #2)?
- Travel time – There was general consensus that this was the priority case to test. There was some discussion as to whether the agency would want to provide comparative travel times, given that most people perceive that they are saving more time in an express lane facility than they actually are. This led to a question: What are the ramifications to agency operating objectives by the provision of certain information?

Other Technical and Operational Issues

Three technical issues were raised.

1. The group placed a strong emphasis on the importance of HMI from a safety and usability perspective. While detailed HMI design is beyond the scope of Phase 2, the human interface was raised as a critical issue.
2. Several participants suggested the use of commercial systems for the communications link and distribution of information (TomTom, etc.) as a way to leverage outside resources at lower public agency expense. There was some discussion about the accuracy of the commercial data, particularly at the lane level.
3. In keeping with the earlier discussion theme of designing technology based on individual needs, an idea was raised for tailored trip information. The user could enter account information and route-specific information (beginning and ending points) and the system would provide price and comparative travel times along with other mode options.

Other Use Cases

The group felt the three recommended use cases presented in the paper were the highest priorities, and had no further discussion on other use cases.

2.4 Final Note

It should be noted that the workshop did not result in one single use case recommendation. All of the above use cases, in their entirety or in parts, will be considered for the Phase 2 testing.

Appendix A - Attendees

In-Person Workshop Attendees

Name	Organization
Marc Deflin	ACS, Inc.
Dominic Paulraj	Arada Systems
Beth Zelinski	Bay Area Toll Authority
Scott Shepard	Bay Area Toll Authority
Ram Kandarpa	Booz Allen Hamilton
Willy Dommen	Booz Allen Hamilton
Ching-Yao Chan	California PATH, UC Berkeley
James Misener	California PATH, UC Berkeley
Cesar Pujol	Caltrans
Fred Yazdan	Caltrans
Kai Leung	Caltrans
Khanh Vu	Caltrans
Alan Chow	Caltrans - District 4
Greg Larson	Caltrans - Research and Innovation
Monica Kress	Caltrans, Traffic Operations Program HQ
David Reinke	Dowling Associates
Dave Kristick	E-470 Public Highway Authority
Eddie Barrios	Fehr & Peers
Rob Rees	Fehr & Peers
Brian Stewart	HDR Engineering Inc.
Stella Maria Joseph	HNTB Corporation
Brian Burkhard	HNTB Infrastructure
Colin Rayman	IBI Group
Michael Berman	ICx Transportation
Alan Clelland	Iteris
Jeffrey Wolff	Kapsch TrafficCom
Suzanne Murtha	Kapsch TrafficCom
Bob McQueen	Kimley-Horn & Associates
Kevin Aguigui	Kimley-Horn & Associates
Robert O'Neill	KPMG LLP
Joan Fisher	LLA
Laura Luster	LLA
Richard Israels	Massachusetts Institute of Technology
Chris Hill	Mixon/Hill, Inc.
Lee Mixon	Mixon/Hill, Inc.
Alysha Nachtigall	MTC
Carol Kuester	MTC
Lisa Klein	MTC
Janet Banner	MTC
Melanie Crotty	MTC
Vamsi Tabjulu	MTC
Teri Argabright	Parsons Brinckerhoff
Erik Berg	PBS&J

Jay Dinkins	PBS&J
Giedrius Praspaliauskas	SAIC
Christopher Burke	San Diego Association of Government
Margaret Cortes	San Francisco County Transportation Authority
Kevin Allen	Southwest Research Institute
Shel Leader	Telvent
Chris Poe	Texas Transportation Institute (TTI)
Ginger Goodin	Texas Transportation Institute (TTI)
Sally Hinds	Traffic Technologies, Inc.
Dick Schnacke	TransCore
Stephen Finn	TransCore
Jonathan Mason	UC Berkeley
Aileen Cabico	URS Corporation
Bob Rupert	USDOT/FHWA, Operations Office of Transportation Management
Benjamin McKeever	USDOT/ITS Joint Program Office
David Kobayashi	Santa Clara Valley Transportation Authority
Vinh Dang	Washington DOT

Webinar Participants

Name	Organization
John Keller	California Highway Patrol
Megan Bucko	California Highway Patrol
David Seriani	Caltrans
Lilibeth Green	Caltrans
Morteza Fahrtash	Caltrans
Tim Baker	Colorado DOT
Roger Berg	DENSO International America, Inc.
Alejandro Diaz	Florida DOT
Elizabeth Birriel	Florida DOT
Daniel Smith	Florida DOT - District 4 (Fort Lauderdale)
Melissa Ackert	Florida DOT - District 4 (Fort Lauderdale)
Stephen Buschmeyer	Fluor Enterprises, Inc.
Cris Sanders	Georgia State Road and Tollway Authority
Patrick Vu	Georgia State Road and Tollway Authority
Reginald Ponder	Georgia State Road and Tollway Authority
Steven Sheffield	Georgia State Road and Tollway Authority
Markus Russold	Kapsch TrafficCom
Tim Wilschetz	KPMG LLP
Julie Johnson	Minnesota DOT
Kenneth Buckeye	Minnesota DOT
Frank Harris	MTC
Joel Markowitz	MTC
Sarah Burnworth	MTC
Todd Westhuis	New York DOT
Neal Denno	Parsons Corporation
Karl Sauer	Riverside County Transportation Commission
Peter Thompson	San Diego Association of Government
Randy Roebuck	SIRIT

John Doan	SRF Consulting
Alex Power	Texas DOT
Flor Tamez	Texas DOT
Roberto Macias	Texas Transportation Institute (TTI)
Jennifer Frankl	Traffic Technologies, Inc.
Barry Pekilis	Transport Canada
Michael Whelan	Transurban
Tony Adams	Transurban USA
Hyungjun Park	University of Virginia, Center for Transportation Studies
Angela Jacobs	USDOT
Frank Cechini	USDOT
Jessie Yung	USDOT
Timothy Crothers	USDOT
Jianling Li	UT Arlington
Melissa Lance	Virginia DOT
Robin Grier	Virginia DOT
Scott Silva	Virginia DOT
Ted Trepanier	Washington DOT
Oscar Correa	

Appendix B – Workshop Agenda



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IntelliDriveSM HOT Lane Workshop

Date: Wednesday, October 21, 2009

Time: 8:30 – 4:00

Location: Metropolitan Transportation Commission
Joseph P. Bort MetroCenter
101 Eighth Street
Oakland, California 94607

Subject: WORKSHOP AGENDA

8:30 AM	Light breakfast provided by MTC
9:00 AM	Welcome and Introductions
9:30 AM	Workshop Purpose and Objectives
9:45 AM	Overview of Regional Express Lane Network
10:15 AM	Break
10:30 AM	Presentation of White Paper “ <i>IntelliDrive Technologies to Support HOT Lane Operations</i> ”
12:00 PM	Lunch provided by MTC
1:00 PM	Q&A on White Paper
1:30 PM	Group Break-out for Facilitated Discussion
2:30 PM	Groups to Report Out on Discussion
3:00 PM	Break
3:15 PM	Summary and Concluding Remarks
4:00 PM	Workshop Ends

Appendix C – Workshop Presentations

IntelliDriveSM HOT Lane Workshop



Carol Koester
Principal Program Coordinator

Janet Banner
Program Coordinator

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Welcome and Introductions

- Workshop is being recorded
- Many attendees on webinar
- Consultants:
 - Mixon/Hill, Inc.
 - Texas Transportation Institute
 - Laura Luster & Assoc.
- Self-introductions around the room

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Agenda for Today

- Workshop Purpose
- Project Background & Overview
- Overview of Regional Express Lane Network
- Presentation of White Paper
- Lunch
- Q & A Session
- Facilitated Discussion
- Summary and Concluding Remarks

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Workshop Purpose and Objectives

- Present findings of the white paper
- Answer questions about findings
- Leverage participants' experience and expertise
- Discuss recommended use cases

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Urban Partnership Program

Urban Partnership Program (UPP) - new federal initiative to reduce traffic congestion using

- congestion pricing
- transit
- tolling
- teleworking

USDOT Selected Seven Communities to Receive Funding:
Atlanta, Chicago, Los Angeles, Miami, Minneapolis Area, San Francisco, and Seattle Area

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UPP in San Francisco Bay Area

- SFpark in San Francisco –
 - Manage parking demand to reduce congestion
- MTC UPP Projects
 - IntelliDriveSM HOT Lane Operations
 - 511 Traveler Information Service
 - Parking information
 - Real-time transit
 - Multimodal trip planner
 - TransLink Smart Card
 - Regional parking payment



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IntelliDrive(SM) Project Overview

- Phase 1 (2009)
 - Develop a white paper
 - Present findings at this workshop
 - Gather public and private agencies' experience and expertise
- Phase 2 (2010 - 2012)
 - Separate procurement
 - Field Testing of recommended use cases
 - Evaluation



White Paper

- Identifies national and local HOT lane challenges
- Scans technologies and protocols
- Analyzes potential use cases, corridors, and fleet options, and provides recommendations
- Develops recommended Phase 2 schedule



Today's Workshop

- Present white paper and answer questions
- Leverage participants' experience and expertise
- Engage in group discussions:
 - Opinions on recommended uses cases (are they the right ones; anything we should do to improve the field tests?)
 - Technical and operational issues (can you add insight to the identified issues and opportunities?)
 - Other recommendations, opportunities, or issues (my preferred use case should be on list because...)

Phase 2

- Demonstration of IntelliDrive technologies and applications (use cases) for HOT lane operations
- Conducted on selected express lane facility in Bay Area
- Phase 2 will be conducted 2010 - 2012



Overview of S.F. Bay Area's Regional Express Lane Network



San Francisco Bay Area

- 9 San Francisco Bay Area counties
- 7,100+ square miles
- 7 million people; almost 4 million jobs
- 101 municipalities



Bay Area Transportation Basics

- 1,400 miles of highways
- 19,600 miles of local streets and roads
- More than 4.5 million cars
- More than 4,300 transit vehicles and 26 transit agencies
- 300 miles of carpool lanes
- 8 toll bridges
- 2nd most congested region in U.S.



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Three Agencies in One

- **MTC**
 - Created by the Legislature in 1971
 - Planner, coordinator, manager and banker
 - Distributes over \$1 billion per year in local, state and federal funds to transportation projects and services
- **BATA**
 - Created by the Legislature in 1998 to administer base toll on bridges
 - BATA is now responsible for the entire \$4 toll
- **SAFE**
 - Created by the Legislature in 1988
 - Oversees network of call boxes and the Freeway Service Patrol
 - Partners with Caltrans and CHP on Freeway Incident Management



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Bay Area 511 Service

- **Multimodal Information**
 - Traffic
 - Transit
 - Ridesharing
 - Bicycling
- Available on the phone (511) & web (511.org) – Free & 24/7
- Driving times on changeable message signs
- Data feed to information service providers



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Bay Area Toll Bridges

- Antioch
- Benicia - Martinez
- Carquinez
- Dumbarton
- Richmond - San Rafael
- San Francisco - Oakland Bay Bridge
- San Mateo - Hayward
- **Golden Gate Bridge** (managed separately by GGBHTD)



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FasTrak

- FasTrak fully deployed in the Bay Area in 2001 for Toll Collection on Bridges
- Current FasTrak Accounts – 800,000
- Current FasTrak Transponders – 1,200,000



- FasTrak is interoperable within California
 - 91 Express Lanes (Orange County)
 - SR-73, SR-133, SR-241 (Orange County)
 - I-15 Express Lanes (San Diego)
 - South Bay Expressway (San Diego)

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What are Express Lanes?

- a.k.a. High-Occupancy Toll (HOT) lanes
- HOV lanes with a twist
 - Carpools, buses free
 - Single drivers can choose to pay (congestion insurance)
 - Electronic tolls
 - Dynamic pricing to manage demand



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HOT Lanes Across the U.S.



Express Lane Network in the Transportation 2035 Plan

- Regional Network is included in the long-range Regional Transportation Plan
- Capital cost of \$3.7 B and net revenue of \$8.1 B (2009 – 2033, escalated)
- Costs and revenues subject to revision via on-going planning



Why a Regional Express Lane Network?

- Proven corridor/system management tool
- Sea change in transportation funding
 - Federal and state accounts going broke
 - National and international trend toward user fees
 - Regionally controlled revenue
- Introduces road pricing concept
- Completes the regional HOV system – 30 years in the making – much faster than traditional public funding

Objectives of the Bay Area's Regional Express Lane Network

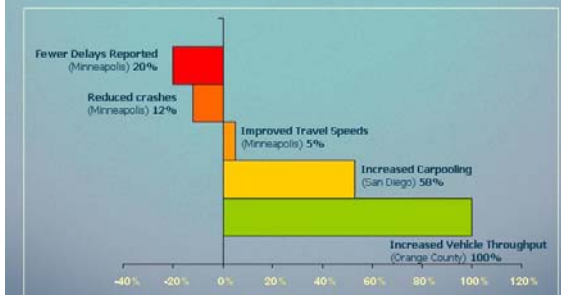
- Provide higher vehicle and passenger throughput
- Reduce delays within each travel corridor
- Provide an efficient, effective, consistent, and seamless network
- Complete the regional HOV system
- Use rapid delivery taking advantage of existing right of way to provide network in an expedited time frame (converting HOV to HOT)
- Use net revenue to provide transit services in corridors
- Use dynamic pricing to protect incentive to carpool or ride transit

Legislation

- Alameda and Santa Clara counties have authority for initial HOT lanes
- Legislation required for a Regional Network: AB 744
 - Corridor-based
 - Steering committee of Caltrans, CHP, BATA and CMAs would advise BATA board
 - BATA would serve as financier



Proven Corridor Management Tool



Bay Area Express Lane Network

- 800 miles total
- 500 miles conversion (63%)
 - 400 existing
 - 100 fully funded
- 300 miles of new lanes (37%)
 - 60% are "gap closures"
 - 5% increase in freeway mileage



Phased Approach

1. Authorized projects in development
2. Easier conversion projects
3. Extremely constrained areas, gap closures and extensions developed last



Break

"IntelliDrive Technologies to Support HOT Lane Operations"

Purpose of White Paper

- Identify specific concepts that are feasible for, and would benefit from, field testing of HOT lane operations using IntelliDrive technologies



White Paper Outline

- HOT lane operations and challenges
 - National perspective
 - Bay Area Express Lane Network
- IntelliDrive program status
- Technologies and protocols
 - Communications technologies
 - Other enabling technologies
 - Vendor scan
- Analysis of potential use cases

White Paper Outline contd.

- Other technical and operational issues
- Analysis of potential demonstration corridors
- Analysis of fleet options
- Phase 2 recommendations
 - Use cases
 - Corridor
 - Schedule
- Prognosis for IntelliDrive HOT lane operations

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National Perspective on HOT Lane Operations and Challenges

Can IntelliDrive technologies support:

- **Enforcement**
 - Accurately monitor vehicle position in buffer zone violations
 - Develop imaging or passenger counting techniques for occupancy violations
- **Traveler information**
 - Provide detailed pricing information by time of day
 - Advise of incidents and other lane operating conditions
 - Provide comparative travel times
- **Monitoring traffic demand and facility performance**
 - Influence driver behavior beyond HOT lane use (e.g. route/mode choice)
 - Integrate with other corridor or regional traffic management strategies

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Bay Area Express Lane Challenges

Challenges identified through stakeholder interviews
(July – September, 2009)

- Alameda County Congestion Management Agency (ACCMA) (Gray-Bowen and Co., Inc.)
- Bay Area Toll Authority (BATA)
- California Department of Transportation (Caltrans)
- California Highway Patrol (CHP)
- Metropolitan Transportation Commission (MTC)
- Santa Clara Valley Transportation Authority (VTA)

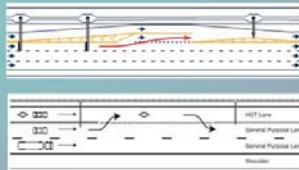
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Bay Area Express Lane Challenges

Challenge: Lane Access

Transition Lane:
Design for I-680

Limited Weave Zone:
Alternative design
being considered for
other corridors



- Can IntelliDrive determine position to the lane level to assess a toll?
- Can IntelliDrive discourage weaving at bottlenecks and tolling points?

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Bay Area Express Lane Challenges

Challenge: Toll Evasion Enforcement

- Initially, LOVs will require a FasTrak tag to use the express lane; HOVs will remove the tag from the windshield
- Plan is to transition to self-declaring FasTrak tags
- Drivers could still mis-declare, but automatic toll violation enforcement via LPR could occur for vehicles not equipped with tags
- Can IntelliDrive support an evolution toward automated enforcement that would address this challenge?

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Bay Area Express Lane Challenges

• Challenge: Enforcement of Occupancy and Buffer Zone Violations

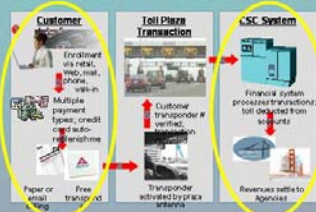
- CHP responsible for occupancy and moving violation enforcement
- Occupancy self-declaration tag with roadside visual cue to CHP officer could help officer target vehicles for visual check
- Can IntelliDrive play a role in a vehicle self-declaring occupancy?
- Can IntelliDrive provide vehicle occupancy information from advanced airbag systems?
- Can near-infrared detection systems be combined with IntelliDrive systems to assist officers?

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Bay Area Express Lane Challenges

Challenge: Back-Office Toll Processing

- FasTrak administration is a significant effort for BATA



- Can IntelliDrive facilitate direct, real-time toll payment through credit cards?

The National IntelliDriveSM Program

- Partnership between the federal, state and local governments, and the automobile industry
- Suite of technologies and applications that use wireless connectivity
 - with and between vehicles,
 - between vehicles and the roadway, and
 - with devices (such as consumer electronics) in the vehicle
- Goal is to achieve transformational safety, mobility and environmental improvements



Scan of Communications Technologies

915 MHz RFID:

- Strengths**
 - Proven solution
 - Established vendors
 - Acceptable costs
- Limitations**
 - Varying implementations
 - Low bandwidth
- Potential Applications**
 - Vehicle ID in tolling
 - Point-to-point probe travel times
 - Lane-level detection with multiple antennas



Scan of Communications Technologies

5.9 GHz Dedicated Short-Range Communications (DSRC):

- Strengths**
 - Designed for V2V and V2I
 - High bandwidth, low latency
 - Secure data transmissions
- Limitations**
 - No large US deployments
 - Outstanding technical issues from VII proof-of-concept tests
- Potential Applications**
 - Vehicle ID & data exchange (tolling, dynamic pricing & acct management)
 - Roadside probe data collection
 - Secure data exchange for financial transactions



Scan of Communications Technologies

3G Cellular:

- Strengths**
 - Established technology; multiple providers
 - Near ubiquitous US coverage
 - Good bandwidth
 - Secure data transmissions
- Limitations**
 - Network latencies; problematic for safety applications
 - Not appropriate for lane-level matching
- Potential Applications**
 - Data exchange for tolling, dynamic pricing and acct management
 - Probe data collection
 - Secure data exchange for financial transactions



Scan of Communications Technologies

Other Technologies Considered:

- WIMAX
- Wi-Fi
- Long-Term Evolution (LTE) / 4G Cellular

Scan of Other Enabling Technologies

Positioning Systems

- Objective: 95% CEP < 1m for lane level positioning
- DGPS is reported to have 95% CEP of 65 cm at 100 km
- VII POC test did not achieve desired accuracy using low cost GPS; report suggests potential solution
- VII POC test did not see improvement using HANDGPS
- Caltrans Carrier Phase DGPS aided INS achieved cm level accuracy, but with high-cost equipment

Bluetooth

- Sensing of Bluetooth devices for collecting travel times

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Analysis of Potential Use Cases

Identifies opportunities and challenges, and provides recommendation for each use case:

- | | |
|--|--|
| <ul style="list-style-type: none"> Toll collection Dynamic pricing In-vehicle account management Back-office toll processing | <ul style="list-style-type: none"> Vehicle occupancy Automated enforcement Probe vehicles Traveler information Regional and corridor traffic management |
|--|--|

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Technical and Operational Issues

- Analysis of other issues to be addressed during Phase 2 field tests:
 - Lane-by-lane vehicle detection
 - In-vehicle driver displays
 - Driver and vehicle privacy

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Potential Express Lane Corridor

- I-880/SR 237 Express Lane
 - VTA to convert HOV-HOV direct connector
 - Will use separated ingress/egress lanes with solid stripes as buffer
 - Express lane reverts to HOV after connector
 - Possible absence of overhead structure and power downstream of connector



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Potential Express Lane Corridor

- I-680 Express Lane
 - 14-mile facility in Alameda and Santa Clara Counties
 - Transition lanes for access with solid stripes as buffer zone
 - 3 entrance points and 3 exit points
 - Overhead structures and power at entrance/exit points
 - T1 connection and wireless communications at each toll zone



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Analysis of Fleet Options

- Test fleets will be required for Phase 2 testing
- Tests of long-term performance or user response may use a large number of commuters and extended period
- Evaluating the limits of a technology may be a structured test for a limited period
- VII POC – 25 dedicated vehicles, but most tests used 1 to 3 vehicles
- Kapsch/E-470 DSRC tests – 27 recruited drivers, with own vehicles, operating for a few weeks

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Phase 2 Recommendations

- Three Use Cases including:
 - Recommended Wireless Communication Protocol(s)
 - Recommended fleet
- One Express Lane Corridor
- Schedule for Phase 2

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Recommended Use Cases

1. Toll Collection
2. Back Office Toll Processing
3. Traveler Information

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Selection Criteria for Use Cases

- Emphasizes IntelliDrive technology(s) that can support the operational needs of the express lanes
- Promises to solve a major challenge identified by a stakeholder
- Is technically feasible in the near-term
- Has potential to offer a significant advance from the current state of the practice in either technology application or express lane operations.

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Use Case # 1 – Toll Collection

Three recommended test scenarios

1. 5.9 DSRC mounted over single lane
 - Evaluate lane level detection
 - Confirm toll collection
 - Evaluate HOT lane continuous access configuration
2. Dual-mode 915 MHz/5.9 DSRC mounted overhead
 - Assess compatibility with existing FasTrak systems
3. 5.9 DSRC mounted at the roadside
 - Confirm toll collection
 - Assess lane-level detection
 - Possibly need high-accuracy positioning system

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Use Case # 1 – Toll Collection

- Fleet recommendations
 - 50 – 100 commuters for long-term system assessment
 - 2 – 5 professional drivers for structured tests
- Evaluate positioning systems
 - Further the assessment performed in the POC
 - Evaluate suggested solutions to low-cost GPS vehicle devices
 - Further evaluate Differential GPS
 - If needed, assess other solutions; e.g., Caltrans snowplow tests

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Use Case # 2 – Back-Office Toll Processing

- Process tolls through direct real-time credit/debit card transactions
- Eliminate need for BATA to administer toll tag and back – office toll processing
- Onboard DSRC equipment could facilitate the transfer of credit card information to the appropriate financial institution
- BATA would then receive payment from the credit card company in a similar manner to other retail transactions
- Similarities with
 - Transit Agencies recent deployment of contactless credit/debit card payment
 - Germany's LKW-MAUT toll collection system for commercial vehicles

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Use Case # 2 – Back-Office Toll Processing

- Utah Transit Authority's new electronic fare collection system
- Accepts major contactless credit and debit cards
- Payment authorization is initiated when a customer taps a contactless credit or debit card to an electronic reader on a train platform or bus.



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Use Case # 2 – Back-Office Toll Processing

- LKW – MAUT: Automated Toll Collection for Trucks in Germany
- Uses OBU, DSRC and Galileo satellite positioning system for mileage-based tolling
- By early 2008, 650,000 OBU units had been installed in heavy goods vehicles



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Use Case # 2 – Back-Office Toll Processing

- Test Scenario
 - Demonstrate driver input of card details and secure communications through DSRC
 - allow the payment of tolls in real-time while minimizing BATA's back-office functions
 - Different in-vehicle equipment configurations: touch screen/keypad and proximity reader with contactless card
 - Requires involvement of financial institution and, possibly, third party service provider for transaction batching
- Fleet Option
 - Install equipment in limited number of vehicles
 - 2 – 5 vehicles per test configuration

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Use Case # 3 – Traveler Information

- Dynamic pricing information
 - Pass information into vehicle using DSRC and 3G
- In-vehicle account management
 - Allow drivers to access account balances using DSRC and 3G
 - Both tests to use professional drivers and limited number of vehicles
- Travel time information
 - Focus on comparative travel times from express and GP lanes
 - Three elements: collection of probe data; processing travel times; dissemination to vehicles
 - Collection using DSRC, 915 MHz and Bluetooth; consider fusing multiple sources
 - Validate techniques for producing travel times, including effects of incidents

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Recommended Corridor

I-680 Corridor recommended based upon:

- Length and configuration of express lane
- Availability of infrastructure



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Recommended Schedule

Recommended Schedule

- System Development & Procurement (Apr – Oct, 2010)
- System Installation (Oct, 2010 – July, 2011)
- Testing (July 2011 – Dec 2011)
- Evaluation & Final Report (Jan – Mar, 2012)

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Lunch Break

The afternoon webinar session will be broadcast via a 2nd webinar "Second Half of the IntelliDrive HOT Lane Workshop."

Please log in using the email confirmation that you received from GoToWebinar.

For assistance, please email Alysha at anacht@mtc.ca.gov

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Q & A Session

Webinar Participants are welcome to submit questions via the webinar software

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Group Break-out for Facilitated Discussion

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Discussion Topics

- Facilitators will work through three topics with each group
- Opinions on recommended uses cases (are they the right ones; anything we should do to improve the field tests?)
- Technical and operational issues (can you add insight to the identified issues and opportunities?)
- Other recommendations, opportunities, or issues (my preferred use case should be on list because...)

Webinar participants: please email your comments to Alysha at anacht@mtc.ca.gov

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Groups to Report Out on Facilitated Discussion

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Break

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Summary and Concluding Remarks

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Thank You!

We would like to acknowledge Dr. Christopher Hill, Mixon/Hill, Inc., whose expertise and tireless effort is very much appreciated!

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Contacts

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E-mail: JBanner@mtc.ca.gov

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Appendix D – Clarification of Proposed Lane Access Approaches in the Bay Area Express Lane Network

The White Paper describes the use of a transition lane design for access, as illustrated in Figure D-1 below. This will be the case in the I-680 corridor. However, alternative access designs, including a limited weave zone, are being considered for other corridors. The limited weave zone approach, illustrated in Figure D-2 below, requires less right-of-way and can be implemented at lower cost.

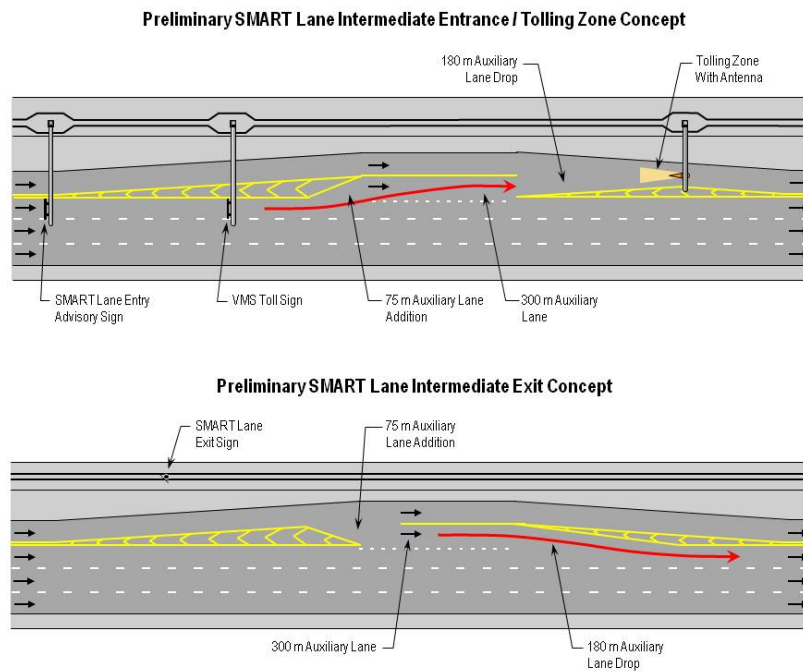


Figure D-1: Transition Lane Design

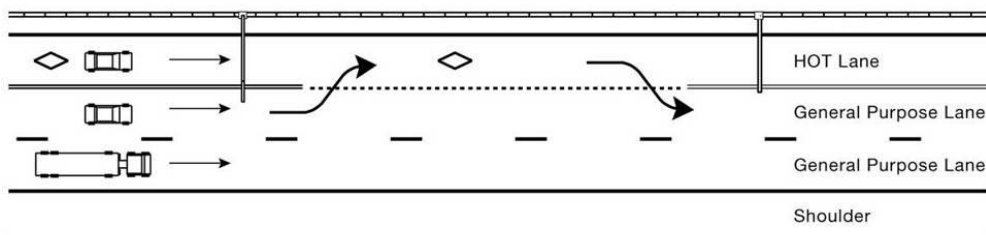


Figure D-2: Limited Weave Zone Design

Appendix E – Vendor Updates

This appendix presents additional information provided by vendors following initial publication of the white paper.

Arada Systems

- Spin-off from WLAN vendor, Atheros Communications;
- Developing products to comply with IEEE 1609 and 802.11p draft standards;
- Current products include:
 - Locomate – 5.9GHz DSRC-based RSU and OBU;
 - LocAir – 915MHz RFID and 5.9 GHz DSRC toll tags.

Sirit

- Reports that it has enhanced its 915 MHz RFID systems to determine speed and lane position when using the ID5100 reader.

Image Automation Ltd.

- Developing products for automated vehicle identification and tracking
- Reports Track-Rite technology is designed to have the ability to monitor and toll a vehicle accurately according to the lane in which it is traveling with a resolution of less than one meter with an accuracy of 99.95%

Appendix F – Interview with CHP

John C. Keller, California Highway Patrol – Special Projects Section, participated in the workshop via webinar. However, a follow-up interview was held with Mr. Keller by Ms. Janet Banner of MTC and project contractor, Chris Hill on October 26, 2009 to more fully explore questions raised by Mr. Keller during the workshop. The discussion is summarized here.

- Mr. Keller said that CHP has significant reservations about continuous access to HOT lanes. To be able to identify any vehicle entering the HOT lane and therefore to be effective for toll collection, it is assumed that 100% of vehicles using the facility would need to be equipped with a DSRC onboard device. Chris noted that these kinds of challenges were among the reasons why continuous access is not emphasized as a component of the recommended uses cases. The toll collection use case is identified as an opportunity to begin an assessment of the technological capabilities of DSRC, perhaps with GPS, to measure vehicle position to the lane-level.
- Mr. Keller added that even if the technology could be demonstrated to provide the necessary capability to measure lane-level positioning, CHP will continue to be concerned about safety and enforcement issues relating to HOT lane continuous access. It was agreed, therefore, that these concerns would be acknowledged and reported in material relating to the project and its proposed demonstration.
- Mr. Keller asked about the robustness of the onboard equipment and the possibility of the motorist tampering with the equipment to avoid paying the toll. Chris acknowledged that it is possible that an individual may attempt to tamper with the system. Dealing with this issue will be an important part of the system design process and may involve efforts to limit the possibility of tampering with the equipment, along with appropriate external enforcement approaches.
- Mr. Keller expressed interest in the project continuing to explore automated vehicle occupancy detection systems, such as the airbag systems described in the white paper. It was agreed that it is desirable to continue this effort. Work will be done to see if the carmakers can support this objective by collaborating in a research effort, as well as by looking at other emerging technologies that may be able to identify and count occupants.

Appendix G – Use Case Mapping

Individual Use Cases	Appropriate for Field Test	Use Case #1 – Toll Collection	Use Case #2 – Back-Office Toll Processing	Use Case #3 – Traveler Information
Toll Collection	Yes	<ul style="list-style-type: none"> • Test 5.9 GHz DSRC range and accuracy – overhead mounted • Test dual mode 5.9 GHz and 915 MHz • Test 5.9 GHz DSRC range and accuracy – side mounted 		
Dynamic Pricing	Yes			<ul style="list-style-type: none"> • Pass dynamic information to vehicle
In-vehicle Account Management	Yes			<ul style="list-style-type: none"> • Pass FasTrak account balance info to vehicle
Back-Office Toll Processing	Yes		<ul style="list-style-type: none"> • Test ability to process toll transactions with credit/debit cards 	
Vehicle Occupancy Detection	No			
Automated Enforcement	Yes	<ul style="list-style-type: none"> • Test positioning systems ability to monitor buffer violations 		
Probe Vehicle Data Collection	Yes			<ul style="list-style-type: none"> • Collection of probe vehicle data
Traveler Information	Yes			<ul style="list-style-type: none"> • Processing probe data and fusing with 511 travel time info • Pass travel time info to vehicle
Regional/Corridor Traffic Management	No			